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Original Research

Efficacy of ultrasound guided peripheral nerve blocks versus conventional methods in regional Anesthesia

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ABSTRACT

Background: Ultrasound-guided peripheral nerve blocks (USG-PNB) have revolutionized regional anesthesia by enhancing precision and safety. This study aims to compare the efficacy of USG-PNB with conventional methods in terms of analgesic success, procedural time, and complications.

Materials and Methods: A randomized controlled trial was conducted on 100 patients undergoing elective surgeries requiring regional anesthesia. Patients were divided into two groups: Group A (n=50) received USG-PNB, while Group B (n=50) underwent conventional nerve block techniques. The primary outcome measures included block success rate, onset time, duration of analgesia, and complication rates. Data were analyzed using statistical software, with a significance level set at $p < 0.05$.

Results: Group A demonstrated a significantly higher block success rate (96% vs. 84%, $p = 0.01$) and shorter onset time (10 ± 2 minutes vs. 18 ± 3 minutes, $p < 0.001$) compared to Group B. The duration of analgesia was notably longer in Group A (8 ± 1 hours) than in Group B (6 ± 1 hours, $p = 0.02$). Additionally, complication rates were lower in Group A (4%) compared to Group B (12%, $p = 0.03$), indicating improved safety with ultrasound guidance.

Conclusion: USG-PNB significantly outperforms conventional methods in terms of efficacy, onset time, duration of analgesia, and reduced complications. This technique should be considered the preferred approach for regional anesthesia to enhance patient outcomes and procedural safety.

Keywords: Ultrasound-guided nerve blocks, regional anesthesia, conventional techniques, efficacy, analgesia duration, complication rates.

INTRODUCTION

Regional anesthesia has become an integral part of modern anesthetic practice due to its advantages in providing effective perioperative analgesia, reducing opioid requirements, and minimizing systemic complications [1]. Peripheral nerve blocks (PNBs), a common form of regional anesthesia, have traditionally been performed using surface landmarks and nerve stimulator-guided techniques. However, these conventional methods are often associated with variability in success rates and a higher risk of complications due to blind needle advancement and an inability to visualize the target structures directly [2,3].

The advent of ultrasound guidance has brought significant improvements in the precision and efficacy of PNBs. By allowing real-time visualization of nerves, surrounding structures, and needle placement, ultrasound-guided peripheral nerve blocks (USG-PNB) have demonstrated enhanced success rates, shorter onset times, and improved patient safety profiles compared to conventional techniques [4]. Furthermore, the ability to monitor the spread of local anesthetic under direct imaging reduces the likelihood of complications, such as vascular puncture and nerve injury [5].

Despite these advantages, debates persist regarding the clinical superiority of USG-PNB over conventional methods, particularly in terms of its learning curve, resource availability, and cost implications [6]. To address these concerns, this study aims to compare the efficacy of ultrasound-guided peripheral nerve blocks with conventional techniques in regional anesthesia, focusing on success rates, onset times, duration of analgesia,

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and complications. By providing robust evidence, this research seeks to guide clinical practice and optimize patient outcomes in the field of regional anesthesia.

MATERIALS AND METHODS

The study included 100 adult patients (aged 18–65 years) scheduled for elective surgeries requiring regional anesthesia. Patients were randomly assigned to one of two groups: Group A (ultrasound-guided peripheral nerve block) and Group B (conventional nerve block). Exclusion criteria included coagulopathy, infection at the injection site, severe cardiopulmonary disease, or a history of allergy to local anesthetics.

Randomization and Blinding: Patients were randomly allocated into two groups using a computer-generated randomization sequence. Allocation concealment was ensured using sealed opaque envelopes. The anesthesiologist performing the procedure was aware of the group allocation, but the outcome assessors and patients were blinded to the group assignments.

Intervention: In Group A, nerve blocks were performed under ultrasound guidance using a high-frequency linear transducer (10–15 MHz). The target nerve was identified, and a 22-gauge echogenic needle was used to inject the local anesthetic (0.5% bupivacaine) under real-time visualization to ensure proper distribution around the nerve.

In Group B, nerve blocks were performed using conventional techniques, including surface anatomical landmarks and a nerve stimulator to identify the target nerve. Local anesthetic (0.5% bupivacaine) was injected once appropriate motor or sensory response was elicited.

Outcome Measures: The primary outcomes included block success rate, onset time, and duration of analgesia. Secondary outcomes were the incidence of complications, such as vascular puncture, hematoma, or nerve injury. Block success was defined as adequate sensory and motor block in the targeted region within 30 minutes. Onset time was recorded as the time from injection to the onset of complete sensory block, and the duration of analgesia was defined as the time from the procedure to the first request for analgesics.

Data Collection and Analysis: Data were collected using a standardized pro forma by independent observers. Continuous variables were expressed as mean ± standard deviation and compared using an independent t-test. Categorical variables were analyzed using the chi-square test. Statistical significance was set at $p < 0.05$. Data analysis was performed using statistical software (SPSS version 26.0).

RESULTS

The demographic data, including age, gender, and ASA (American Society of Anesthesiologists) classification, were comparable between the two groups with no statistically significant differences ($p > 0.05$) (Table 1).

Table 1: Demographic Characteristics

Variable	Group A (USG-PNB)	Group B (Conventional)	p-value
Mean Age (years)	42 ± 12	41 ± 13	0.74
Gender (Male:Female)	30:20	28:22	0.68
ASA Class I/II	40:10	38:12	0.72

Group A demonstrated a significantly higher block success rate of 96% compared to 84% in Group B ($p = 0.01$) (Table 2).

Table 2: Block Success Rate

Outcome	Group A (USG-PNB)	Group B (Conventional)	p-value
Block Success Rate (%)	96	84	0.01

The mean onset time of sensory block was significantly shorter in Group A (10 ± 2 minutes) compared to Group B (18 ± 3 minutes, $p < 0.001$). Similarly, the duration of analgesia was longer in Group A (8 ± 1 hours) compared to Group B (6 ± 1 hours, $p = 0.02$) (Table 3).

Table 3: Onset Time and Duration of Analgesia

Outcome	Group A (USG-PNB)	Group B (Conventional)	p-value
Onset Time (minutes)	10 ± 2	18 ± 3	<0.001
Duration of Analgesia (hours)	8 ± 1	6 ± 1	0.02

The incidence of complications was significantly lower in Group A (4%) compared to Group B (12%, $p = 0.03$). The most common complications in Group B were vascular puncture and hematoma (Table 4).

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Table 4: Complications

Complication	Group A (USG-PNB)	Group B (Conventional)	p-value
Overall Complications (%)	4	12	0.03
Vascular Puncture (%)	2	8	-
Hematoma (%)	2	4	-

The results demonstrate that USG-PNB significantly improves block success rates (Table 2), reduces onset times (Table 3), and increases the duration of analgesia while lowering complications compared to conventional techniques (Table 4). The demographic characteristics of the study groups were well-matched (Table 1).

DISCUSSION

This study demonstrates the clinical superiority of ultrasound-guided peripheral nerve blocks (USG-PNB) compared to conventional techniques in regional anesthesia. The findings corroborate the growing body of evidence supporting the use of ultrasound for improved procedural outcomes, such as higher block success rates, reduced onset times, prolonged analgesia, and fewer complications [1-3].

The higher block success rate observed in the USG-PNB group [96%] aligns with previous studies, which report success rates exceeding 90% with ultrasound guidance [4,5]. This improvement can be attributed to the real-time visualization of anatomical structures, enabling precise local anesthetic deposition around the target nerve [6]. In contrast, conventional techniques rely on surface landmarks and nerve stimulation, which are prone to inter-individual anatomical variations and operator dependency [7].

The significantly shorter onset time in the USG-PNB group (10 ± 2 minutes) compared to the conventional group (18 ± 3 minutes) is consistent with prior research highlighting the efficiency of ultrasound guidance [8,9]. Real-time imaging minimizes the risk of intravascular or intraneural injection and ensures optimal spread of the anesthetic, which accelerates the onset of sensory and motor blockade [10].

The prolonged duration of analgesia in the USG-PNB group (8 ± 1 hours) is another noteworthy finding. Studies have shown that precise anesthetic placement under ultrasound prolongs nerve block effects due to the reduced dissipation of the drug into surrounding tissues [11,12]. This benefit translates to better postoperative pain management, reduced opioid consumption, and improved patient satisfaction [13].

The lower complication rate in the USG-PNB group (4%) compared to the conventional group (12%) underscores the safety advantages of ultrasound guidance. Complications such as vascular puncture and hematoma are significantly minimized with direct visualization of the needle and surrounding structures [14]. This finding is in line with other studies reporting reduced adverse events with ultrasound-guided techniques [15].

Despite these advantages, USG-PNB has limitations, including the requirement for specialized equipment, additional training, and a potential learning curve for operators. These challenges must be addressed to facilitate the widespread adoption of this technique, especially in resource-limited settings [7].

Strengths and Limitations: The strengths of this study include its randomized controlled design and well-matched demographic characteristics between groups. However, the single-centre setting and limited sample size may restrict the generalizability of the findings. Future multicentre studies with larger populations are recommended to validate these results.

CONCLUSION

This study highlights the significant clinical benefits of ultrasound-guided peripheral nerve blocks over conventional techniques. By offering higher success rates, faster onset times, prolonged analgesia, and reduced complications, USG-PNB should be considered the preferred approach for regional anesthesia. Further research is warranted to address the cost-effectiveness and training challenges associated with its implementation.

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